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PRELIMINARY
OPERATING INSTRUCTIONS
FOR THE
Q COMPARATOR
TYPE 265-A

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U. S. A.

MP MASTER
MA24362

SPECIFICATIONS

Radio Frequency Characteristics

RF Range

Total Range: 200 kc to 70 mc
Number of Ranges: 10 (through use of seven Type 520-A Oscillator Inductors)

Band Ranges:

Inductor	Range	Frequency
520-A1	A	50 - 70 mc
520-A2	A	30 - 50 mc
520-A3	A	15 - 30 mc
520-A4	A	8 - 16 mc
520-A5	B	2 - 4 mc
	A	4 - 8 mc
520-A6	B	550 kc - 1 mc
	A	1 - 2 mc
520-A7	B	200 - 300 kc
	A	300 - 550 kc

RF Accuracy: May be set to within ±0.5% with external standard

Q Measurement Characteristics

Q Range: 30 to 500

% Q Range: ±25% of standard

% Q Accuracy: ±5% on 25% range

% Q Calibration: increments of 5%

Inductance Capacitance Measurement Characteristics

L Range: 0.15μh to 15 mh*

C Range: 5$\mu\mu$f to 0.01μf*

R Range: 500Ω to 20 megΩ*

* Actual range depends upon test frequency

% L-C Range: ±5% or ±20% of standard - full scale

% L-C Accuracy: Direct reading to ±20% of % L-C range (for L between 1μh and 15mh and C between 500μμf and 0.01μf)

Comparison to ±10% of limit standards (for L between 0.15μh and 15mh and C between 5μμf and 0.01μf)

% L-C Calibration: 1% increments on ±5% range
5% increments on ±20% range

Accessories

Furnished: (1) Type 520-A Oscillator Inductor (Range specified by customer)

Available: Type 520-A Oscillator Inductors (Ranges Listed Above)
Type 103-A Inductors

Tube Complement

3 - 0A2	2 - 12AU7A
4 - IN55A	6 - 12AX7
1 - 5ABP1	4 - M150 Rectifier
2 - 6AU8A	2 - NE2
1 - 6C4	

Physical Characteristics

Mounting:

Indicator Unit - cabinet for bench use; by removal of end bells, suitable for 19-inch rack mounting

Oscillator-Detector Unit-cabinet for bench use

Dimensions:

Indicator Unit - Height: 9-1/32 inches
Width: 19 inches
Depth: 10-1/4 inches

Oscillator-Detector Unit - Height: 5-11/64 inches
Width: 10-13/16 inches
Depth: 8-1/8 inches

Weight:

Net 40 lbs.
Gross Domestic: 50 lbs.
Gross Export: 82 lbs.
Legal Export: 46 lbs.

Power Requirements

265-A: 105-125 volts, 60 cps, 115 watts

INSTALLATION

Remove the Q Comparator from its packing carton and place it on a level test bench or table; the Oscillator-Detector Unit at the front of the test position and the Indicator unit at the rear. The Indicator Unit has provision for rack mounting if this type installation is desired.

Plug the connector on the Oscillator-Detector Unit cable into the receptacle below the CRT on the Indicator Unit. Install a Type 520-A Oscillator Inductor, of appropriate frequency range, in the socket at the left side of the Oscillator-Detector Unit. Set the FREQ RANGE switch to the correct frequency range, as indicated on the oscillator inductor scale label, and adjust the oscillator inductor control to the desired test frequency.

Connect the power cord at the rear of the Indicator Unit to a 105 to 125-volt, 50 to 60-cycle power source. Set the Power Switch to the ON position and allow the Q Comparator to warm up for at least 1/2 hour.

CONTROLS AND INDICATORS

The following controls are adjusted during the set up procedure only, and should not be disturbed during operation of the Q Comparator.

Control	Function
Power Switch	Connects instrument to power source
Pilot Lamp	When lighted, indicates that power is connected to instrument
Motor Switch (Rotating Capacitor)	Controls power to driving motor for rotating sweep capacitor
FREQ RANGE Switch	Selects A or B frequency range as required by oscillator inductor in use
520-A Oscillator Inductor Frequency Tuning Control	Tunes oscillator output frequency
SELECTOR SWITCH	Provides proper circuit connections for adjusting CRT display
CENTER Q	Adjusts vertical position of CRT display

L-C TRACE POSITION	Adjusts horizontal position of CRT display
CAL Q	Adjusts gain of vertical amplifier
L-C TRACE WIDTH	Adjusts gain of horizontal amplifier
INTENSITY	Adjusts brightness of CRT display
High-Low Capacitance Switch	Selects test circuit capacitance range
HI-Q - LO Q Switch	Changes level of oscillator outputso that SET Q OF STD controls are effective when measuring both low Q and high Q components (Generally operated in LO Q position)
Resonating Capacitors	Adjust capacitance in test circuit
SET Q OF STD - COARSE	Coarse adjustment of oscillator injection into Q circuit
SET Q OF STD - FINE	Fine adjustment of oscillator injection into Q circuit
DOT POSITION	Provides means for positioning dot to peak of resonance curve.
FOCUS	Adjusts sharpness of dot
ASTIGMATISM	Adjusts symmetry of dot

INITIAL SET UP PROCEDURE

The following procedure should be performed before the Q Comparator is put into operation, from time to time during prolonged usage, and after tube or other component replacements.

Center Frequency Tuning

The Q Comparator is tuned to the desired center frequency by means of the 520-A Oscillator Inductor plugged into the left side of the Oscillator-Detector Unit. If greater accuracy than that afforded by the 520-A Oscillator Inductor calibration is desired, the Oscillator Inductor frequency adjustment may be made as follows:

1. Connect a frequency standard, meter, or counter across one set of HI and GND binding posts on the Oscillator-Detector Unit.

2. Remove the button plugs at the top left-hand corner and left side of the Oscillator-Detector Unit cover.

3. Turn the rotating capacitor shaft by pressing the rubber eraser end of a wooden pencil against the shaft end through the hole in the left side of the cover. Hold the detent plunger (accessible through the hole in the top of the cover) depressed, and rotate the shaft until it is detented.

4. With the capacitor shaft in this detented position, refine the Oscillator Inductor frequency control adjustment to obtain the desired frequency.

5. Release the capacitor detent and turn on the capacitor drive motor. The displayed center frequency will now be within ±3% of the frequency of the standard. If a still more precise setting is desired, see paragraph C of the Appendix.

CENTER Q Adjustment

Set the SELECTOR switch to the CENTER Q position and turn the INTENSITY control full clockwise. Adjust the CENTER Q control until a horizontal trace is displayed on the CRT. Sharpen the display with the FOCUS and ASTIGMATISM controls, then adjust the CENTER Q Control until the trace is displayed along the center-line axis (0% Q) of the Q scale on the CRT.

CAL Q Adjustment

Set the SELECTOR to the CAL Q position and adjust the CAL Q control until the CRT trace is aligned with the -25% marking at the bottom of the Q scale. Switch the SELECTOR to the CENTER Q position and recheck the CENTER Q adjustment.

L-C Trace Adjustment

Set the SELECTOR to the CENTER Q position and the L-C TRACE WIDTH control inner slotted shaft to the ±20% (counterclockwise) position. Adjust the L-C TRACE WIDTH control outer knurled shaft and the L-C TRACE POSITION control until the displayed trace extends from the left-hand vertical dashed line to the right-hand vertical dashed line at the extremes of the L-C scale. The horizontal L-C scale will now read, directly, per cent variations in L or C up to ±20% compared to a standard for values of L from 1.0μh to 15 mh and for values of C from 500 $\mu\mu$f to 0.01 μf. For other values, tolerance limits must be set up as explained under "Establishing Tolerance Limits".

±5% Trace Width Adjustment

After the Q Comparator has been adjusted to provide ±20% trace width, as explained under "L-C Trace Adjustment", the instrument may be switched to provide ±5% sweep width by merely rotating the L-C TRACE WIDTH control inner shaft to the ±5% (clockwise) detent position. A slight centering error may be apparent in the ±5% position. This may be corrected by readjusting the L-C TRACE POSITION control.

Setting Q of Standard

Before the Q Comparator can be used to test a component, the CRT display must be set up with a measured standard of the test component resonated in the test circuit as follows:

1. With the SELECTOR in the USE position, connect the standard to one set of HI and GND binding posts on the Oscillator-Detector Unit.

NOTE: In order to avoid serious hand-capacitance effects, components with one terminal connected to a shield must be connected with the shield terminal to the grounded binding post.

2. Set the Resonating Capacitor switch (located between the Oscillator-Detector Unit binding posts) to the High or Low position as required. The capacitance range is 45 to 570 $\mu\mu$f in the High position and 30 to 45 $\mu\mu$f in the Low position. Disconnect one end of the terminal strap for Low position.

3. Position the HI Q - LO Q switch to the LO Q position. At some frequencies, low C components of high Q may require that this switch be set to the HI Q position in order that the adjustment in step 7 may be made.

4. Adjust the SET Q OF STD - COARSE control and the Resonating Capacitor until a resonance curve is displayed on the CRT. (Actually, because of the slight nonlinearity of the sweep voltage, two resonance curves will be displayed.) Tune from maximum capacitance of the resonating capacitor and select the resonance occurring with the most capacitance. This will insure that the resonance curve displayed is a fundamental curve and not an unwanted harmonic of the oscillator.

5. Turn the DOT POSITION control until a dot appears and is positioned at the peak of one of the resonance curves, then reduce the intensity with the INTENSITY control until the curves disappear and only the dot is visible.

6. Adjust the FOCUS and ASTIGMATISM controls until the dot is round and of sufficient intensity and minimum size.

7. With the SET Q OF STD - Fine control set at the center of its range, adjust the SET Q OF STD-COARSE control so that the dot is displayed as near as possible to the vertical center (0% Q) of the CRT. If a large adjustment is required, it may be necessary to retouch the resonating capacitor adjustment (step 4).

8. Adjust the SET Q OF STD-Fine control and refine the resonating capacitor adjustment so that the dot is positioned at the exact center (0% Q and 0% L-C) of the CRT.

NOTE: The resonating capacitor should be adjusted only while the standard is connected in the test circuit. Changing this adjustment during the component testing operation will invalidate the calibration of the Q Comparator.

9. Set the SELECTOR switch to the CENTER Q position, turn up the intensity, and recheck the CENTER Q adjustment.

10. Switch the SELECTOR to the CAL Q position, and recheck the CAL Q adjustment.

11. Switch the SELECTOR to the USE position and reduce the intensity. Refinement of the SET Q OR SET L control and the resonating capacitor control may be required if any adjustments were made in steps 9 or 10.

ESTABLISHING TOLERANCE LIMITS

In order to display Q instantaneously over a range of ±20% or ±5% in the reactance of the unknown, the frequency of the Q Comparator test signal is automatically and continuously varied. Thus -20% reactance corresponds to +12% frequency and +20% reactance is achieved by a deviation of -8.6% in frequency; the numbers being derived from the inverse square root relationship between capacitance and frequency.* For those components having a negligible variation of Q with frequency over the selected reactance sweep range, (1.0μh to 15mh and 500μμf to 0.01μf) the direct-reading calibration of the %Q and %L-C scales on the CRT is satisfactory.

Q Tolerance Limits

In cases where the Q of a component varies rapidly with frequency and it is necessary to inspect to a close Q tolerance (±10% or better), variation in the expected Q of the standard over the selected reactance (frequency) range must be determined. This is necessary in order that the limits may be adjusted in line with the law of variation of the Q with frequency of the components under test. The preferred method for determining this variation is as follows:

1. Measure the Q of the standard component, against which the comparator is to be set up, at frequencies corresponding to the zero reactance and the desired limit reactance values. This should be done on a Type 260-A Q Meter.

2. From these measurements, calculate the percentage deviation of Q against frequency.* If, for example, the standard has a Q which is 10% higher at minus 8.6% in frequency, the Q limit which corresponds to the +20% end of the reactance scale should be raised by 10%. A similar process would be followed at the minus reactance end of the scale.

3. Draw a grease pencil line on the reticule of the CRT to indicate the Q variation of the standard over the frequency (reactance) range as calculated in step 2. The line must pass through the origin of the coordinates (0%Q and 0% L-C)

4. Draw two additional limit lines parallel to the line showing the performance of the standard and spaced from the standard line by the desired Q tolerance. These lines will pass through the desired Q tolerance on the vertical (%Q) axis.

* See the Appendix for calculation.

NOTE: In many cases, typically those in which reactance sweeps of ±5% are used, the preceding procedure will be unnecessary, because the variation in Q of the standard over the reactance limits chosen is negligible compared to the Q limits to which the component is being inspected.

L-C Tolerance Limits

For coils of less than 1 μh, the test circuit residual inductance of approximately 0.015 μh deteriorates the accuracy of the direct reading L-C scale. For best accuracy, the following procedure is recommended.

1. Set up the components to the desired inductance limits in the Type 260-A Q Meter, correcting for the internal residual inductance of the Q Meter.

2. Adjust the L-C TRACE WIDTH and L-C TRACE POSITION controls so that the above limit components read the desired tolerance.

For capacitors of less than 500 μμf, the test circuit minimum capacitance of 30 μμf will reduce the direct reading accuracy of the L-C scale. For best accuracy, a procedure similar to the one used for coils above is recommended.

TESTING PROCEDURE

After the initial set up procedure has been completed and the tolerance limits have been marked on the reticule of the CRT, disconnect the standard component from the test circuit binding posts and connect a test component in its place. The comparator may now be used as a simple "go--no-go" device. If the characteristics of the test component are such that a dot appears on the CRT within the marked tolerance limits, the component is considered acceptable. If the dot is displayed outside the marked limits, the test component is considered a reject. Further manipulation of controls or interpretation of results is unnecessary.

Recheck of Standard Display

The Q Comparator should be checked for center position with the test standard at least once each hour during normal operation. If the half-hour warm up period is not employed, the test standard should be checked at least twice in the first half hour and again at the end of an hour. Occasional recheck of the L-C TRACE WIDTH setting is also desirable, especially if the oscillator frequency is changed.

A. Capacitance (or Inductance) and Frequency Relationship

The relationship between capacitance (or inductance) and frequency is shown by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Since capacitance is the actual reactance varied, this may be written:

$$f = \frac{1}{2\pi\sqrt{L}\sqrt{C}} = \frac{K}{\sqrt{C}} = KC^{-1/2} \quad \text{where } K = \frac{1}{2\pi\sqrt{L}}.$$

Now at +20% limit of reactance,

$$f_2 = \frac{K}{\sqrt{C_2}} = \frac{K}{\sqrt{1.2C}} = \frac{K}{1.093}C^{-1/2} = 0.914KC^{-1/2}.$$

In percent, $\Delta f = \frac{f_2 - f}{f} \times 100$

$$\Delta f = \frac{(0.914-1)\,KC^{-1/2}}{KC^{-1/2}} \times 100 = -0.086 \times 100$$

$$\Delta f = -8.6\%.$$

Similarly: $f_1 = \frac{K}{\sqrt{0.8C}} = 1.12KC^{-1/2}$ and

$$\Delta f = \frac{f_1 - f}{f} \times 100 = 0.12 \times 100 = +12\%.$$

A similar process using

$$f = \frac{1}{2\pi\sqrt{C}\sqrt{L}} = KL^{-1/2} \quad \text{where } K = \frac{1}{2\pi\sqrt{C}}$$ yield

identical results.

B. Calculation of Percentage Deviation of Q against frequency

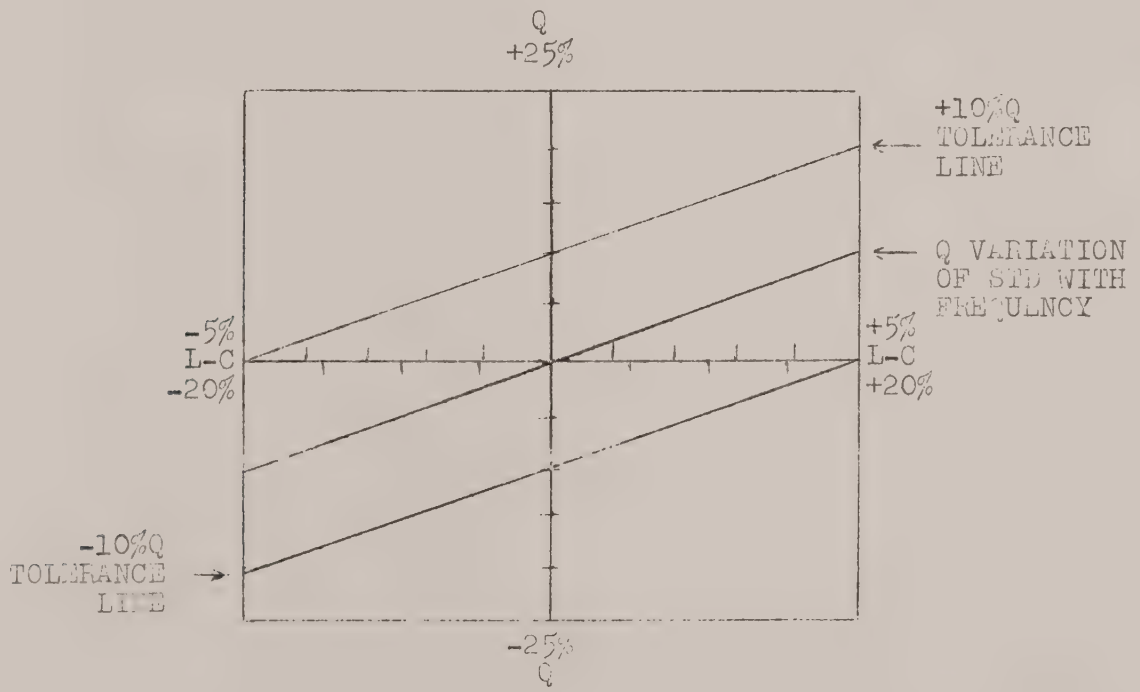
Assuming a test frequency of 2 mc, the variation of Q with frequency of the test standard is determined as follows:

(1) Measure the Q of the test standard (on a 260-A Q Meter) at zero reactance or 2 mc. Assume the Q is 100.

(2) Measure the Q of the test standard at a frequency 8.6% lower than 2 mc or 1.828 mc. Assume the Q is 110. This means that the Q is 10 percent higher at a frequency 8.6% lower than the test frequency (corresponding to +20% reactance on the L-C scale of the Q Comparator).

(3) Measure the Q of the test standard at a frequency +12% higher than 2 mc or 2.24 mc. Assume the Q is 90. This means that the Q of the standard is 10% lower at a frequency +12% higher than the test frequency (corresponding to -20% reactance on the L-C scale of the Q Comparator).

(4) The marking on the Q Comparator reticule representing the expected Q variation of the test standard would then be drawn to reflect a 10% high Q reading at the -20% end of the reactance scale and a 10% low reading at the +20% end of the reactance scale. Tolerance lines would then be drawn parallel to the standard line (above and below) to indicate the desired tolerance as shown below.



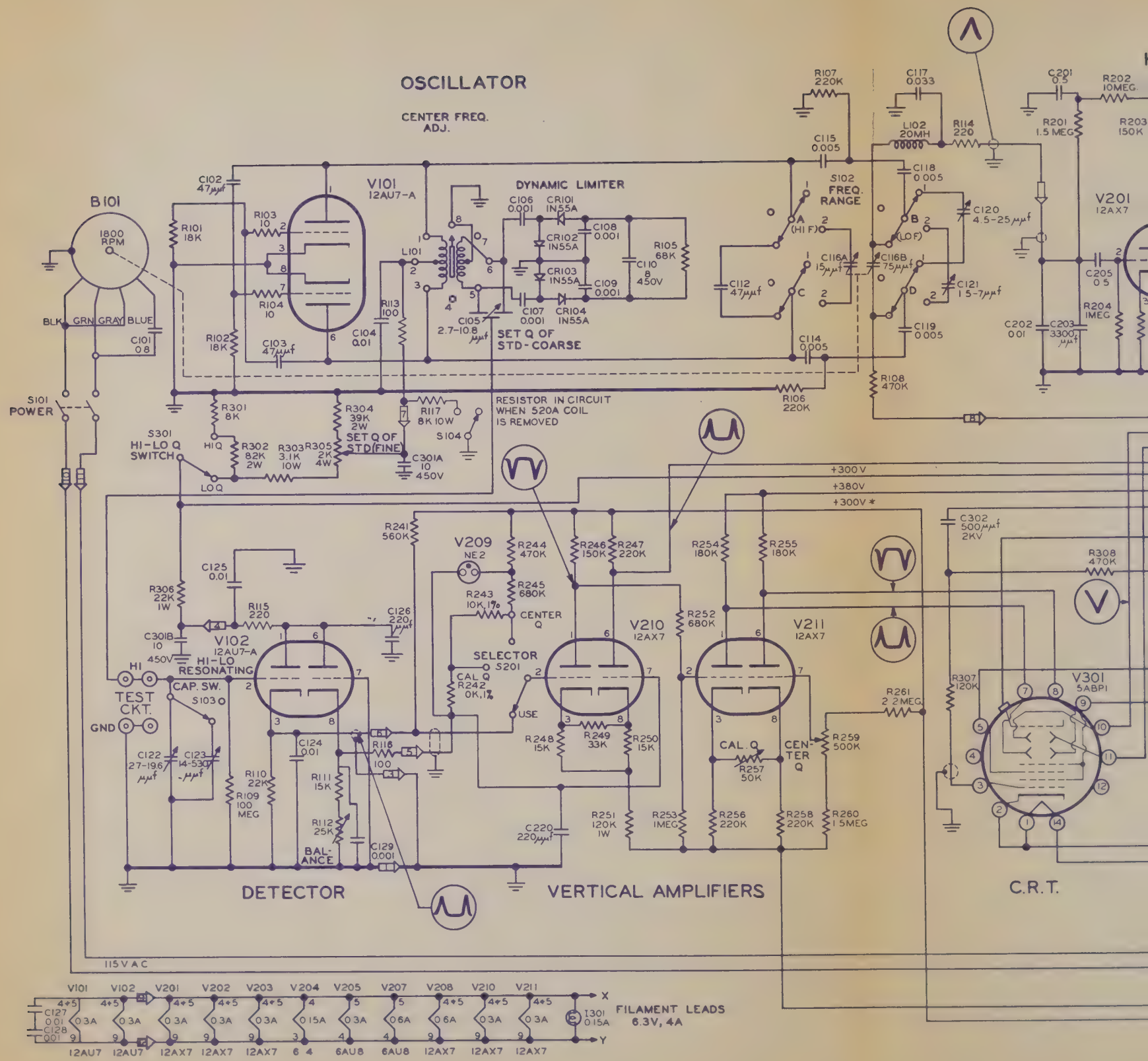
C. Precise Setting of Test Circuit Center Frequency

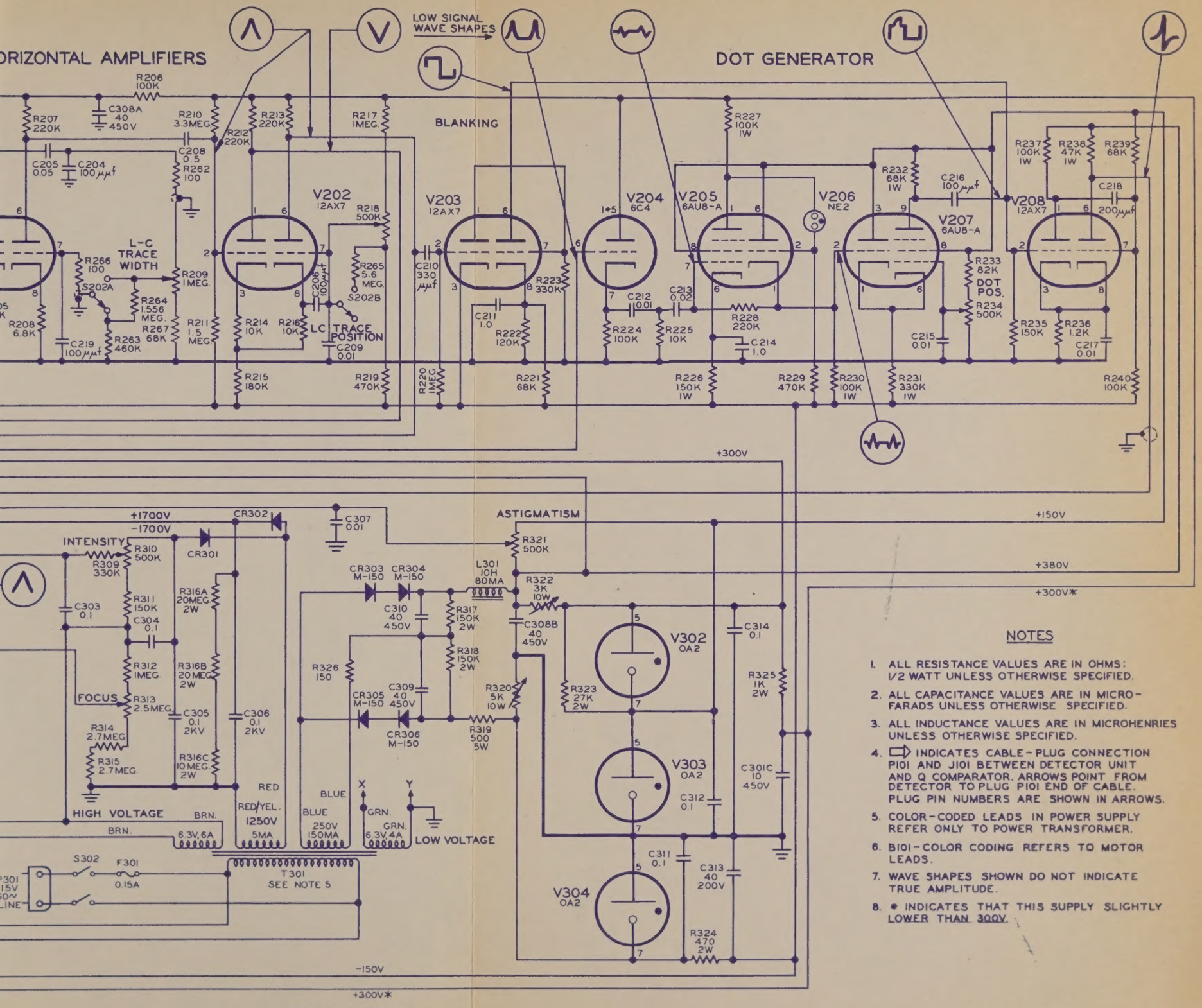
1. Secure an oscillator or signal source of the desired accuracy and covering the desired frequency range. It should be capable of suppling 1 volt or more to a 50-ohm load

2. Loosely couple the output of this source to a test coil which is resonated approximately at the desired frequency and centered on the CRT as in step 8 under "Setting Q of Standard".

3. As the external oscillator is tuned through the test circuit resonance, the dot will appear to oscillate up and down due to the beat frequency generated. The point of maximum excursion indicates near equality between the 265-A oscillator frequency and the external oscillator frequency at the peak of the test circuit resonance.

4. The 520-A Oscillator Inductor tuning control may now be adjusted to position the dot so that it indicates the test circuit resonant frequency on the CRT to within ±0.5% of the external oscillator.


OSCILLATOR
CENTER FREQ. ADJ.
B101
1800 RPM
BLK GRN GRAY BLUE
V101 12AU7-A
DYNAMIC LIMITER
SET Q OF STD-COARSE
S102 FREQ. RANGE
V201 12AX7
S101 POWER
S301 HI-LO Q SWITCH
SET Q OF STD (FINE)
RESISTOR IN CIRCUIT WHEN 520A COIL IS REMOVED
+300V
+380V
+300V*
V209 NE2
V102 12AU7-A
HI-LO RESONATING CAP. SW. S103
TEST CKT.
SELECTOR S201
CAL Q R242 10K 1%
CENTER Q
V210 12AX7
V211 12AX7
BAL-ANCE
DETECTOR
VERTICAL AMPLIFIERS
V301 5ABP1
C.R.T.
115 V A C
FILAMENT LEADS 6.3V, 4A
V101 V102 V201 V202 V203 V204 V205 V207 V208 V210 V211
12AU7 12AU7 12AX7 12AX7 12AX7 6 4 6AU8 6AU8 12AX7 12AX7 12AX7



NOTES

1. ALL RESISTANCE VALUES ARE IN OHMS: 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITANCE VALUES ARE IN MICRO-FARADS UNLESS OTHERWISE SPECIFIED.
3. ALL INDUCTANCE VALUES ARE IN MICROHENRIES UNLESS OTHERWISE SPECIFIED.
4. ⇨ INDICATES CABLE-PLUG CONNECTION P101 AND J101 BETWEEN DETECTOR UNIT AND Q COMPARATOR. ARROWS POINT FROM DETECTOR TO PLUG P101 END OF CABLE. PLUG PIN NUMBERS ARE SHOWN IN ARROWS.
5. COLOR-CODED LEADS IN POWER SUPPLY REFER ONLY TO POWER TRANSFORMER.
6. B101-COLOR CODING REFERS TO MOTOR LEADS.
7. WAVE SHAPES SHOWN DO NOT INDICATE TRUE AMPLITUDE.
8. * INDICATES THAT THIS SUPPLY SLIGHTLY LOWER THAN 300V.

TYPE 265-A SCHEMATIC

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